PATENT ABSTRACTS OF JAPAN

(11)Publication number : **09-176769**

(43)Date of publication of application : **08.07.1997**

(51)Int.Cl. C22C 21/02

(21)Application number : **07-351019**

(22)Date of filing : **25.12.1995**

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(54) **WEAR RESISTANT ALUMINUM ALLOY**

(57)Abstract:

PROBLEM TO BE SOLVED: To produce an Al alloy for extrusion molding excellent in wear resistance, pressure withstanding strength, potential difference corrosion resistance, extrusion moldability and machinability by specifying the componental structure consisting of Mg, Si, Mn and Al.

SOLUTION: This Al alloy for extrusion molding is the one having a compsn. contg., by weight, 0.4 to 1.0% Mg, 3.0 to 6.0% Si and 0.1 to 1.0% Mn, furthermore contg., at need, one or more kinds among 0.15 to 2.0% Cu, 0.05 to 0.30% Cr, 0.01 to 0.10% Ti and 0.1 to 1.0% Fe, and the balance Al with inevitable impurities, and in which extrusion molding conditions are regulated to obtain an extrusion molded material having $\leq 50\mu m$ grain size.

LEGAL STATUS

[Date of request for examination] 10.04.2001

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Mg: The aluminum alloy for extrusion molding characterized by having 0.4-1.0 % of the weight, Si:3.0-6.0 % of the weight, and Mn:0.1-1.0 % of the weight, and having the component organization where the remainder consists of aluminum and an unescapable impurity.
[Claim 2] Mg: The extrusion-molding profile which has 0.4-1.0 % of the weight, Si:3.0-6.0 % of the weight, and Mn:0.1-1.0 % of the weight, and has the component organization where the remainder consists of aluminum and an unescapable impurity, and is characterized by the diameter of crystal grain being 50 micrometers or less.
[Claim 3] Mg: The aluminum alloy for extrusion molding characterized by having 0.4-1.0 % of the weight, Si:3.0-6.0 % of the weight, and Mn:0.1-1.0 % of the weight, having two of one sort or Cu:0.15-2.0 % of the weight, Cr:0.05-0.30%, Ti:0.01-0.10 % of the weight, and Fe:0.1-1.0% of the weight of sorts or more further, and having the component organization where the remainder consists of aluminum and an unescapable impurity.
[Claim 4] Mg: The extrusion-molding profile which has 0.4-1.0 % of the weight, Si:3.0-6.0 % of the weight, and Mn:0.1-1.0 % of the weight, has two of one sort or Cu:0.15-2.0 % of the weight, Cr:0.05-0.30%, Ti:0.01-0.10 % of the weight, and Fe:0.1-1.0% of the weight of sorts or more further, and has the component organization where the remainder consists of aluminum and an unescapable impurity, and is characterized by the diameter of crystal grain being 50 micrometers or less.

[Translation done.]

Drawing selection drawing 1

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the aluminum extrusion-molding profile with which the field which needs sliding functions, such as braking components for automobiles, especially is presented about the aluminum alloy excellent in abrasion resistance.
[0002]
[Description of the Prior Art] The alloy aiming at the improvement of extrusion nature is indicated maintaining abrasion resistance generally by depositing Mg2 Si in aluminum by distributing hard Si particle in aluminum by adding a lot of Si like 4032 specified to JISH4140 as an alloy currently used for the purpose of abrasion resistance, and adding Si and Mg to JP,5-57436,B.
[0003]
[Problem(s) to be Solved by the Invention] The effectiveness of improving extrusion nature is accepted to the aluminum alloy with which surely Si addition exceeds 6% like 4032 alloys, maintaining abrasion resistance for Mg by 1.9% or more of addition. However, when Mg was added 1% or more in the case of the extrusion product which it is the effectiveness only about the extrusion product which has easy configurations, such as the round bar, and has a variant cross-section configuration, already carrying out extrusion molding had the technical problem that it became very difficult. Moreover, it asked for the aluminum alloy ingredient in the braking components for automobiles etc. with which pressure resistance, a potential difference-proof corrosive, etc. may be simultaneously required only in addition to mere abrasion resistance, the ingredient stickiness nature at the time of caulking for further with a components group may also be needed, and it is satisfied of these demand characteristics about the technical field as which the abrasion resistance in lubricating oil Nakashita, such as the so-called brake FURUIDO, is required about the wear environment.
[0004]
[Means for Solving the Problem] this invention person added various components in aluminum first, fabricated the extruded section with extrusion, and did **** experiment research about each quality characteristic and extrusion molding. Consequently, it results in this invention and The means for solving a technical problem is described with the knowledge acquired by experiment below. There are components of various kinds many in the control-section article for automobiles, and an anti-lock brake system AKUCHUE turbo day, a brake wheel cylinder, a clutch master cylinder, a proportioning valve, etc. are the examples of representation. Although there are a casting, a forging, and extrudate in the aluminum alloy with which these are presented, especially this invention is a thing about extrudate. Moreover, sliding nature is required into the lubricating oil of various kinds [these], such as the so-called brake Froude.
[0005] It became clear that abrasion resistance will begin to improve from about 2.0%, remarkable wear-resistant effectiveness will be accepted by addition 3.0% if an addition is increased for Si one by one from 1.0% and an abrasion resistant test is carried out, lifting of wear-resistant effectiveness will become loose near 5.0% if Si is added further, and a balance was mostly reached at 6.0% or more.

Moreover, addition of Si 6.0% or more accepted not only the cutting tool wear in cutting but aggravation of the field relative roughness by Si particle. Therefore, 3.0 - 6.0% of Si addition is appropriate, and becomes 3.5 - 5.5% ideally. When just Si addition of reinforcement is inadequate as extrusion-molding material, Mg is required for presenting an automobile control-section article 0.4% or more and Mg was added 1.0% or more, extrusion-molding nature began to fall suddenly. Next, experiment research of the addition effectiveness of Mn and Cu was done for the purpose of cutting ability and a potential difference corrosive improvement effect.
[0006] Mn can adjust the diameter of crystal grain with combination with the extrusion conditions mentioned later, if it adds 0.1% or more, and it became clear that it can improve cutting ability and a potential difference corrosive (henceforth anti-corrosiveness). However, there is a fault the grain community corrosion which adds Mn 1.0% or more becomes easy to generate. Moreover, since anti-corrosiveness will fall if there are many additions of Cu, when thinking the corrosion prevention effectiveness as important, 0.15 - 1.0% of range is good [while Cu contributes to solid solution hardening in aluminum, when cutting ability's improves and it thinks cutting ability as important, 0.3 - 2.0% of its addition is good, but]. Therefore, it is effective for reconciling the quality characteristic which starts Cu:0.3-1.0% of ideally. Cr and Ti have the detailed-ized effectiveness of crystal grain, and are added if needed. At 0.05% or less, this effectiveness cannot be found, and in 0.30% or more, Cr fabricates a huge primary phase product and worsens elongation. At 0.01% or less, similarly Ti does not have detailed-ized effectiveness and the effectiveness is not only saturated with 0.10% or more, but it reduces the tool life at the time of a cut. Fe: Although there are detailed-izing of crystal grain and an improvement effect of machinability 0.1-1.0%, if it exceeds 1.0%, the effectiveness is saturated and the effectiveness runs short at 0.1% or less. In order to fully demonstrate the property of an aluminum alloy, not only an aluminum alloy presentation but fabricating-operation conditions are very important elements.
[0007] Especially, the solution treatment after the homogenization conditions of an aluminum billet, extrusion-molding temperature, and extrusion molding and artificial-aging conditions are important, and extrusion molding of an aluminium alloy is explained in full detail below. The homogenization after aluminum billet casting has the desirable conditions of 480-590 degree-Cx 6-hour or more maintenance so that dissolution-ization of an addition component can fully be secured. Below 480 degrees C, since original homogenization is not made, homogenization of an alloy content or an organization, a deposit of the component which dissolved to supersaturation, etc. have an adverse effect on reinforcement and crystal grain. Above 590 degrees C, since there is a possibility of producing eutectic fusion, it has an adverse effect on reinforcement and crystal grain. The temperature at the time of extrusion molding has 450 degrees C or more desirable 510 degrees C or less. Below 450 degrees C, extrusion is difficult and it is because crystal grain makes it big and rough, and is set to 50 micrometers or more, so it has an adverse effect on anti-corrosiveness above 510 degrees C. For that purpose, control of billet temperature is also important and it becomes the factor in which billet temperature makes 50 micrometers or more make crystal grain big and rough on the contrary below 450 degrees C by lifting of the temperature increase by plastic working at the time of extrusion, and above 510 degrees C, billet temperature is high and it becomes the cause of making a front face producing a crack at the time of extrusion molding.
[0008] By subsequent artificial aging, below 500 degrees C, reservation on the strength is [solution-ized insufficiency] difficult also for the solution treatment after extrusion molding, and crystal grain will make it big and rough above 560 degrees C. Moreover, subsequent artificial-aging conditions are set up in consideration of reservation on the strength and caulking nature. Ideally, the range of 510-540 degrees C is desirable. Below 510 degrees C, an alloying element does not fully dissolve and sufficient engine performance is not obtained in a final product. Above 540 degrees C, since crystal grain makes it big and rough and is set to 50 micrometers or more, it has an adverse effect on anti-corrosiveness, and reinforcement and elongation are worsened. Artificial-aging temperature has desirable 180-200 degrees C, and it should decide on aging time amount with artificial-aging temperature from a viewpoint of the reinforcement required of a product, and a manufacturing cost.
[0009]

[Example] A table 2-1 and the alloy ingot of the presentation of alloy NO.A shown in 2-2 were prepared. After homogenizing the cylindrical ingot of this 8 inch phi at 480-590 degrees C for 6 hours or more, it heated at 450-510 degrees C, and hot extrusion processing was performed. The extruded section was made into the variant profile shown in drawing 1 - drawing 3 . Solution-ization is quenched for 10 minutes after 500-560 degree-Cx 3-hour maintenance after cutting by 100mm in an extruded section at 40-degree-C water temperature. Then, T6 processing in which artificial aging was held for 180-200 degree-Cx 3 hours was performed. Thus, the extrusion nature of the obtained extruded section, a mechanical property, crystal grain, etc. were examined with the following test method. The result is shown in a table 3-1, 3-2, 3-3, and 3-4. Moreover, a table 2-1 and the alloy ingot of the various presentations shown in 2-2 were adjusted. After homogenizing the cylindrical ingot of this 8 inch phi at 510 degrees C for 6 hours, it heated at 470 degrees C, and the cutting back was performed for the extruded section and solution-ization was quenched for 10 minutes by 100mm at 40-degree-C water temperature after 520 degree-Cx 3-hour maintenance. Then, T6 processing in which artificial aging was held for 195 degree-Cx 3 hours was performed. Thus, the hot extrusion workability of the obtained extruded section, a mechanical property, corrosion resistance, abrasiveness, etc. were examined with the following test method. The result is shown in a table 4-1, 4-2, 4-3, and 4-4.
[0010] <Test method> The maximum extrusion rate which can be extruded without making the front face of (1) hot-extrusion workability extruded section produce a crack was measured, and this estimated the extrusion nature of each of said alloy.
(2) From the extruded section processed mechanical property T6, the test piece for tensile test of a JIS No. 5 piece was extracted, and it examined according to JISZ2241.
(3) Process the extruded section processed corrosion-resistant T6 like drawing 4 , make a table 1 into a basic cycle after attaching and making a DAKURO bolt the screw section, and it is 10 cycle **********. Assessment measured the corrosion depth of the DAKURO bolt contact surface and near.

表１

《塩水浸漬×湿潤の繰り返し５回》

〈塩水浸漬〉
５％塩水　３０℃
０．５時間

→

〈湿潤〉
９５％×５０℃湿潤
２３．５時間

↓

《強制乾燥》
８０℃×４８時間

(4) The abrasiveness LFW abrasion tester performed the abrasion test of the following conditions, and the abrasion loss by the side of an extruded section was measured.

摩耗条件
- リング材：ＳＵＪ２
- 荷重　：４１２Ｎ
- 試験時間：１０時間
- 用途　：２０８ｒｐｍ（３８１ｍ／ｓ）
- 潤滑　：ブレーキフルード

[0011]
[0012]

表２－１

	NO.	合金名	組成（ｗｔ％）							
			Ｓｉ	Ｆｅ	Ｃｕ	Ｔｉ	Ｍｎ	Ｍｇ	Ｃｒ	Ｚｎ
本発明合金材	1	A	4.04	0.28	0.15	0.05	0.20	0.60	0.15	0.01
	2	B	1.05	0.28	0.15	0.05	0.19	0.60	0.15	0.00
	3	C	1.84	0.29	0.15	0.05	0.20	0.60	0.15	0.01
	4	D	3.02	0.28	0.15	0.05	0.19	0.58	0.14	0.01
	5	E	3.51	0.29	0.16	0.05	0.20	0.61	0.14	0.01
	6	F	5.50	0.29	0.15	0.05	0.20	0.62	0.14	0.01
	7	G	6.03	0.28	0.15	0.05	0.19	0.60	0.15	0.01
	8	H	4.06	0.28	0.15	0.05	0.19	0.98	0.15	0.01
	9	I	4.06	0.28	0.15	0.05	0.19	0.40	0.15	0.01
	１０	J	4.04	0.29	0.15	0.05	1.01	0.60	0.15	0.01
	１１	K	4.04	0.29	0.15	0.05	0.11	0.60	0.15	0.01

[0013]

表２－２

	NO.	合金名	組成（ｗｔ％）							
			Ｓｉ	Ｆｅ	Ｃｕ	Ｔｉ	Ｍｎ	Ｍｇ	Ｃｒ	Ｚｎ
本発明合金材	１２	Ｌ	4.07	0.29	0.98	0.05	0.18	0.58	0.15	0.01
	１３	Ｍ	4.04	0.28	2.01	0.05	0.19	0.60	0.15	0.01
	１４	Ｎ	4.02	0.28	0.15	0.01	0.19	0.60	0.05	0.01
	１５	Ｏ	4.02	0.28	0.15	0.10	0.19	0.60	0.30	0.01
	１６	Ｐ	3.97	1.01	0.14	0.05	0.20	0.81	0.15	0.01
比較材	１７	Ａ	7.03	0.29	0.15	0.05	0.29	1.04	0.15	0.00
	１８	Ｂ	0.73	0.19	0.15	0.06	0.15	0.98	0.14	0.00
	１９	Ｃ	12.10	0.18	1.10	0.01	0.00	0.28	0.00	－
	２０	ＡＣ２Ｂ	5.70	0.40	3.00	0.00	0.10	0.20	－	0.20
	２１	ＪＩＳ ４０３２	12.10	0.40	0.90	－	－	1.00	－	－

[0014]

表３－１

均質化処理温度（℃）	押出温度（℃）	溶体化温度（℃）	人工時効温度（℃）	押出加工性（m／分）	結晶粒（μm）
480	470	520	195	3.5	110
		540	195	3.5	120
510	450	520	195	1.0	110
	470	500	195	3.5	20
		510	180	3.5	30
			195	3.5	30
			200	3.5	30
		520	180	3.5	30
			195	3.5	30
			200	3.5	30

[0015]

表3－2

均質化処理温度（℃）	押出温度（℃）	溶体化温度（℃）	人工時効温度（℃）	押出加工性（m／分）	結晶粒（μm）
		540	180	3.5	35
			195	3.5	35
			200	3.5	35
		560	195	3.5	100
	510	520	195	1.0	80
		540	195	1.0	90
545	470	520	195	3.5	30
		540	195	3.5	35
590	470	520	195	3.5	120
		540	195	3.5	120

[0016]

表3－3

均質化処理温度(℃)	押出温度(℃)	溶体化温度(℃)	人工時効温度(℃)	機械的性質		
				引張強度(MPa)	耐力(MPa)	伸び(%)
480	470	520	195	303	263	9.4
		540	195	327	291	8.5
510	450	520	195	271	245	8.7
	470	500	195	277	245	8.2
		510	180	327	283	11.0
			195	336	291	10.6
			200	343	302	10.0
		520	180	342	298	10.7
			195	350	310	10.5
			200	376	333	9.8

[0017]

表３－４

均質化処理温度（℃）	押出温度（℃）	溶体化温度（℃）	人工時効温度（℃）	機械的性質		
				引張強度（MPa）	耐力（MPa）	伸び（%）
		540	180	362	320	10.5
			195	388	347	10.0
			200	390	349	9.7
		560	195	323	275	5.0
	510	520	195	327	291	7.9
		540	195	347	315	7.0
545	470	520	195	346	308	10.2
		540	195	376	349	10.0
590	470	520	195	274	234	6.0
		540	195	257	209	5.2

[0018]

表4－1

	NO.	合金名	押出加工性 (m／分)	機械的性質		
				引張強度(MPa)	耐力(MPa)	伸び (%)
本発明合金材	1	A	3.5	350	310	10.0
	2	B	5.0	343	299	12.0
	3	C	4.5	345	304	10.6
	4	D	4.5	341	304	10.5
	5	E	4.0	345	303	10.5
	6	F	3.0	375	359	8.0
	7	G	3.0	378	362	7.2
	8	H	1.0	397	358	8.5
	9	I	4.5	278	254	8.3
	10	J	1.5	340	306	8.0
	11	K	3.5	331	298	9.0

[0019]

表4－2

	NO.	合金名	押出加工性(m／分)	機械的性質		
				引張強度(MPa)	耐力(MPa)	伸び（%）
本発明合金材	12	L	2.0	398	362	9.0
	13	M	1.0	404	370	7.0
	14	N	4.0	342	302	10.0
	15	O	3.5	353	317	6.5
	16	P	2.0	340	315	6.0
比較材	17	A	1.0	387	356	6.0
	18	B	6.0	343	305	13.0
	19	C	0.5	352	258	11.9
	20	AC2B	－	245	245	1.7
	21	JIS 4032	0.5	392	313	7.0

[0020]

表4－3

	NO.	合金名	結晶粒 (μm)	耐食性 (孔食深さ) (mm)	摩耗性 (摩耗量) (mm)
本発明合金材	1	A	30	0.5	3.35
	2	B	30	0.2	10.76
	3	C	30	0.3	5.48
	4	D	30	0.5	3.83
	5	E	30	0.5	3.46
	6	F	30	0.4	3.00
	7	G	30	0.4	2.99
	8	H	30	0.5	3.21
	9	I	30	0.5	3.17
	10	J	20	1.2	3.15
	11	K	45	0.4	3.20

[0021]

表4－4

	NO.	合金名	結晶粒 (μm)	耐食性 (孔食深さ) (mm)	摩耗性 (摩耗量) (mm)
本発明合金材	12	L	30	1.0	3.18
	13	M	30	1.6	3.17
	14	N	30	0.5	3.17
	15	O	75	0.7	3.20
	16	P	80	0.6	3.15
比較材	17	A	30	0.4	2.92
	18	B	30	0.1	測定不能
	19	C	50	0.6	2.48
	20	AC2B	－	2.5	2.84
	21	JIS 4032	30	1.0	2.80

[Translation done.]